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SLOVENIAN SOCIETY FOR EMERGENCY MEDICINE

Urgentna medicina

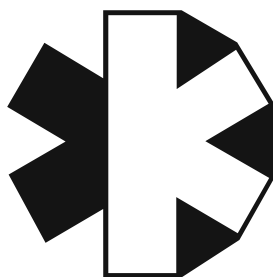
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Emergency Medicine
selected topics

24.

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2017



SLOVENSKO ZDRUŽENJE ZA URGENTNO MEDICINO
SLOVENIAN SOCIETY FOR EMERGENCY MEDICINE

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Rajko Vajd

Marko Gričar

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NADZOR VITALNIH FUNKCIJ S POMOČJO BIOSENZORJA IN PODPORO INTELIGENTNE TEHNOLOGIJE

CONTINUOUS VITAL PARAMETERS MONITORING BY USING BIOSENSORS AND SMART TECHNOLOGY SOLUTION

Bojana Koteska, Natasa Kosecka**, Monika Simjanoska*, Anton Jost***,
Andrej Strahovnik***, Radko Komadina****, Magdalena Kostoska*,
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ABSTRACT

In this paper we present wireless solution for continuous monitoring of vital parameters by using the leverage of both the biosensors and the smart technology. The proposed solution consists of three commercially available biomedical sensors and a portable smart technology device. The integration allows continuous capture of the heart rate, respiratory rate, part-time blood pressure and oxygen saturation. The application enables insight into the recent history of the parameters, additionally providing information of the shock index, Glasgow comma scale score and the hemodynamic stability of the patient. The solution is suitable for pre-hospital, during the vehicle transport and in-hospital environment. Given all the hardware used is commercially available, the integration is highly cost effective when compared to the hospital equipment. The reliability has been tested in hospital environment.

INTRODUCTION

State-of-the-art biosensors technology provides the opportunity for continuous monitoring of the individuals' physiological parameters. The advantage of using biosensors is recognized by the smart technology's ability to obtain this data and process it in real time, making it beneficial for both the individual's (personal monitoring) and the physicians (providing diagnosis) [1]. There is a trend for developing such applications that gather data from various biosensors. The diversity between the applications arises from the purpose of development. Some are aimed for sport activities monitoring [2, 4] (personal usage) and others for abnormalities detection and on-time alarming [3, 6]. Therefore, they serve to the preventive medicine as well as to the curative medicine.

In this paper we present a smart technology solution, mainly focused in the curative medicine domain. It comprises multiple commercial biosensors into one application providing continuous wireless monitoring of the heart rate and the respiratory rate, wireless monitoring of the blood pressure and the oxygen saturation, additionally providing history charts of the four parameters as well as information of the shock index. The solution proposed is original since it provides additional functionalities that can be used in major incidents [5], the ability to obtain Glasgow comma score, save the given medicaments, or mark the injured body parts in case of incident. Those features are dismissed in the other applications based on the same type of biosensors [7, 8].

SMART WEARABLE BIOSENSORS

Our solution integrates three commercially available biosensors. For extracting heart rate and respiratory rate we use the Zephyr Bioharness sensor [9] that streams data at a frequency of 250 Hz. The automatic MyTech Wrist Cuff Blood Pressure Monitor sensor [10] is used for measuring blood pressure and Nonin Saturated Blood Oxygen device for measuring oxygen saturation (SPO2) [11]. The integration scenario of the three biosensors is shown in Fig. 1. MyTech Wrist Cuff Blood Pressure Monitor sensor and Nonin Saturated Blood Oxygen device communicates with Zephyr Bioharness biomodule by their MAC addresses. The data from these biosensors are first sent to Zephyr Bioharness sensor which is directly connected to the medic smart device by using the Bluetooth protocol. Zephyr Bioharness sensor is responsible for sending all the data to the medic smart device. The data received can be sent to remote server and used for further analysis of the patient's health condition.

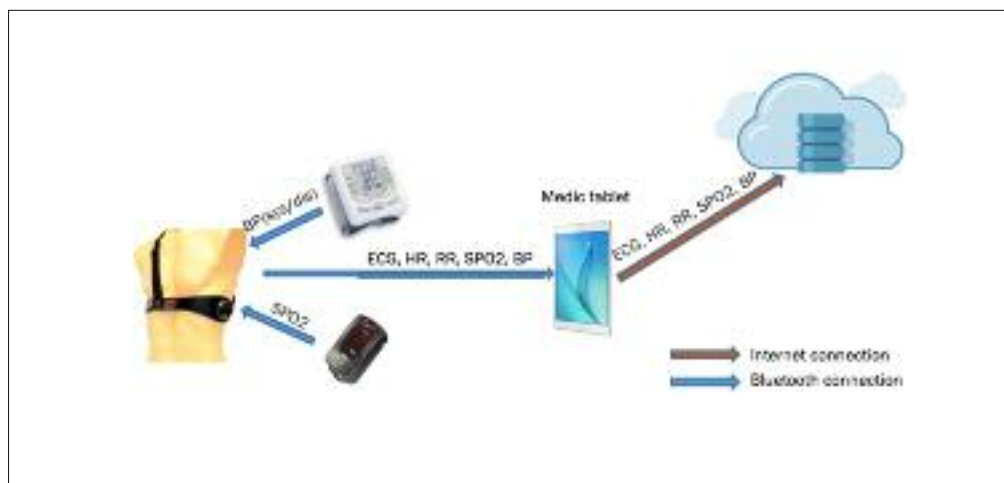


Figure 1.

SOFTWARE SOLUTION FOR WIRELESS MONITORING OF VITAL PARAMETERS

Several screens from the developed software system intended for remote monitoring of patient vital parameters are shown in Fig. 2. Real time measured vital parameters are shown on the first screen. The top menu provides option for taking picture of the patient injured body parts and buttons for connecting/disconnecting from the Zephyr Bioharness sensor. There are two other available options provided on the bottom menu: level of injury and medications. The history from the last hour of the heart rate, respiratory rate and shock index are presented on the second screen. Shock index is calculated as a ratio of heart rate and systolic blood pressure.

If a Level of injury tab is selected, the Glasgow coma scale (GCS) and Injured body parts tabs became available. Glasgow coma scale (GCS) calculation is shown in the third screen and it contains groups of radio buttons for eye opening, verbal response and motor response. Each item in the corresponding group has proper value and the label below shows the sum of the selected items. Injured body parts tab shown in the fourth screen contains an image of human body where injured body parts can be marked with different level of injury. Additionally, the user can select medications that were given to the patient. All the data are stored locally on the smart devices and in a remote database.

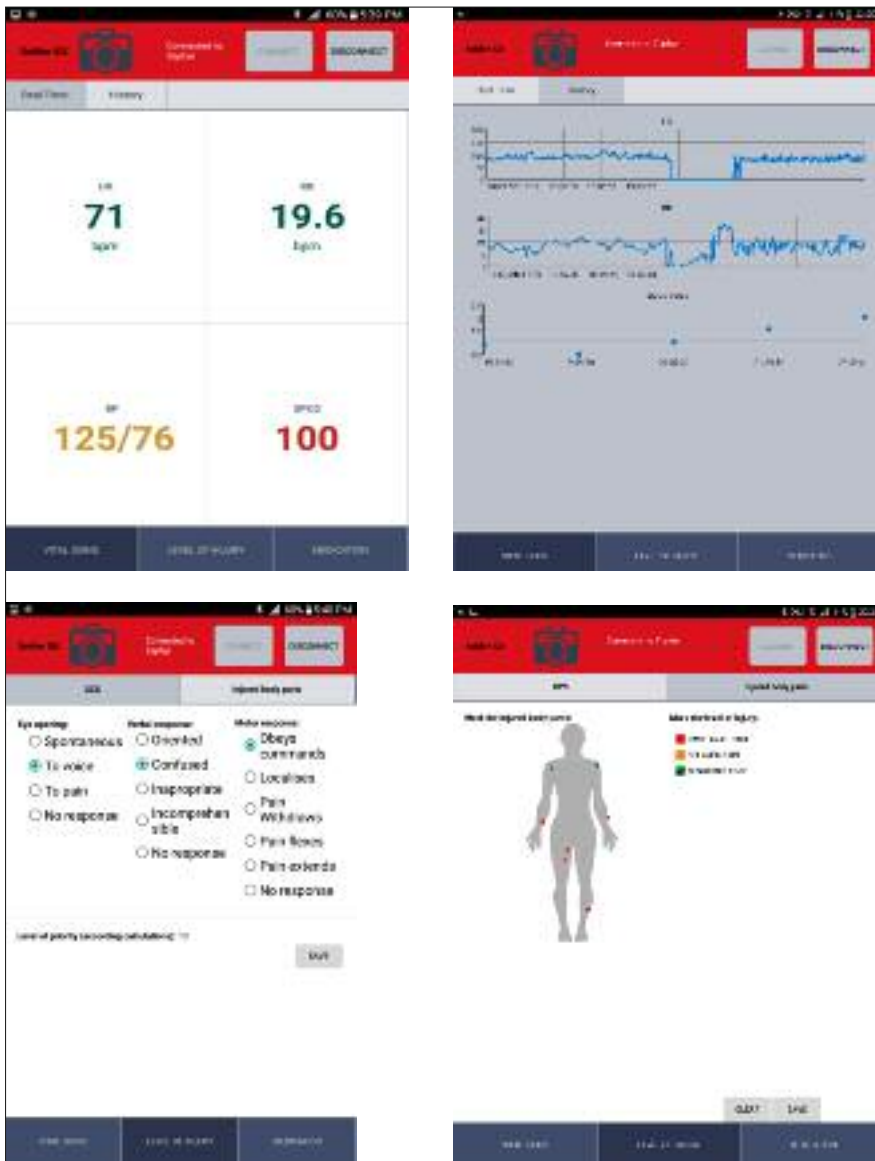


Figure 2. Software application screens

PROS AND CONS OF THE PROPOSED SOLUTION

Biosensors implementation has both advantages and disadvantages. It can be beneficial in terms of:

- **Real time vital parameters monitoring** – the patients' parameters can be continuously monitored and transferred.
- **Vital parameters history** – the data obtained are saved and can be easily accessed by whoever needs them;
- **Wireless solution** – it is practical and user-friendly in all circumstances;
- **Portable solution** – it is built for smart devices that can be either tablets or mobile phones;

- **Aids the secondary triage** – support for Glasgow comma scale computation;
- **Cost-effective** – all the biosensors used are commercially available and are affordable.

The main disadvantage is the **battery capacity** of the smart devices. If the case demands longer continuous monitoring, then the device needs to be recharged periodically. No other constraints are noticed.

CONCLUSION

In this paper, we propose smart technology solution that provides continuous vital parameters monitoring by using biosensors technology. The solution is based on three commercially available biosensors able to capture the heart rate, respiratory rate, blood pressure and oxygen saturation, and therefore to transfer the data via Bluetooth to the portable smart device. The developed application provides additional features as the history of the vital parameters, the shock index, the Glasgow comma scale score, the possibility to input given medicaments, and even the ability to select the level of injury according to the medical protocols. Those additional features make the application to be suitable not only for personal/hospital monitoring, but also in pre-hospital circumstances in cases of incidents, or in the vehicle during transport.

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REFERENCES

1. Mendes, J. J. A., Vieira, M. E. M., Pires, M. B., & Stevan, S. L. (2016). Sensor fusion and smart sensor in sports and biomedical applications. *Sensors*, 16(10), 1569.
2. Venkatraman, P. D., et al. »Smart wearable biosensor for non-invasive real time detection of sweat lactate using compression garments.« (2016).
3. Ajami, Sima, and Fotooheh Teimouri. »Features and application of wearable biosensors in medical care.« *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences* 20.12 (2015): 1208.
4. Castillejo, Pedro, et al. »Integration of wearable devices in a wireless sensor network for an E-health application.« *IEEE Wireless Communications* 20.4 (2013): 38–49.
5. Gao, Tia, et al. »Wireless medical sensor networks in emergency response: Implementation and pilot results.« *Technologies for Homeland Security, 2008 IEEE Conference on. IEEE*, 2008.
6. Lehocki, Fedor, et al. »Yet another hypertension telehealth solution? The rules will tell you.« *Biomedical Engineering and Sciences (IECBES), 2014 IEEE Conference on. IEEE*, 2014.
7. Online available at: <http://www.mobogenie.com/download-zephyrme-74441.html>
8. Online available at: <https://senseview.mobi/>
9. Online available at: <https://www.zephyranywhere.com/system/components>
10. Online available at: <https://senseview.mobi/supported-sensors/128-mytech-fully-automatic-wrist-blood-pressure-monitor-hpl-108.html>
11. Online available at: <http://www.nonin.com/Normal-Oxygen-Level>